

**REMARKS**

Claims 1-34 are currently pending in the application. By this amendment, claims 1-4, 6, 10, 12, 15, 16, 20, 21, 27-29, 32 and 33 are amended for the Examiner's consideration. The above amendments do not add new matter to the application and are fully supported by the specification. The specification is also amended to correct minor typographical errors. Reconsideration of the rejected claims in view of the above amendments and the following remarks is respectfully requested.

***Objection to Claims***

Claims 4, 10 and 33 were objected to. These claims have been amended to address the Examiner's concerns. As such, Applicant requests the objection to be withdrawn.

***35 U.S.C. §112 Rejection***

Claims 6 and 20 were rejected under 35 U.S.C. §112, 2<sup>nd</sup> paragraph. This rejection is respectfully traversed. Claims 6 and 20 are amended to clarify the invention. As to claim 20, Applicant submits that the spray can be either a flat fan spray or conical spray design. Accordingly, Applicant respectfully requests that the rejection over claims 6 and 20 be withdrawn.

***35 U.S.C. §102 Rejection***

Claims 1-34 were rejected under 35 U.S.C. §102(b) for being anticipated by the U.S. 2002/0061270 to Osborne. This rejection is respectfully traversed.

To anticipate a claim, each and every claim feature must be shown in a single prior art reference, either expressly or inherently. MPEP § 2131. Applicant submits that Osborne does not show all of the features of the claimed invention.

By way of background the present invention, at page 2, lines 7 to 19, and following pages to page 7, clearly discloses that the prior art confines control of SO<sub>2</sub>, NOx, particulates, mercury, dioxin/furans, to the low gas temperatures of several 100°F in the boiler exhaust ducting,

immediately upstream of the particulate collectors, which requires costly equipment and incurs high operating costs, especially in consumables. This is especially the case for control of mercury with activated carbon injection where a reduction of as little as 30°C from 140°C to 110°C doubled the Hg reduction, and required only a 285 parts carbon to 1 Hg weight (page 26, lines 1 through 8). However, unless SO<sub>2</sub> is removed upstream, as in the claimed invention, as gas temperatures drop below the H<sub>2</sub>SO<sub>4</sub> dew points, sulfuric acid will form and attack boiler exhaust ducts. Therefore, coal power plants operate above this temperature, where Hg control with activated carbon requires up 100,000 to 1 C/Hg ratio (page 18, lines 20-22) Also, the upstream removal of the other pollutants, SO<sub>2</sub>, NO<sub>x</sub>, Chlorine, dioxins/furans, and trace metals, including mercury, will remove them as sites for attracting activated carbon, thereby greatly reducing the quantity of activated carbon needed for remaining mercury removal.

The benefit of being able to operate much below the acid dew point is even greater for dioxin and furan control, where lowering the gas temperature 230°C to 120°C reduced emission in one MSW incinerator by a factor of 1000. (page 23, lines 5 to 7). This cooling effect can be seen in figure 4 and figure 5. Fig.4 shows the temeprature change, while figure 5 shows the effect of temp on dioxin/furans. This is in addition to the benefit of using activated carbon at much reduced concentrations.

Osborne operates entirely in the low gas temperature range of several 100°F, and thus requires extensive and costly chemical components to control emissions, as discussed below. In sharp contrast, the claimed invention uses a sequential removal of the pollutants beginning in the nominal 3000°F gas temperature combustor down to near ambient temperature conditions where the remaining pollutant, mercury, is removed with very little of the costly activated carbon. For example, in the claimed invention, two groups of process steps control the emissions. One group is implemented in the combustor, which all people knowledgeable in the field of combustion know occurs at around 3000°F. The second group occurs in “post combustion zones”, which covers the entire range from less than about 2600°F to about 200°F. Each of these temperature zones is identified as to its purpose in controlling specific pollutants, either partially or wholly.

For example, each temperature zone is described briefly in the Summary of the Invention (pages 28, line 19 through page 35, line 9).

Group 1 occurs in the combustion chamber (page 30, line 6 though p.32, line 10). Group 2 (p. 32, line 13 through p.35, line 9) occurs in the immediate post combustion zones from about 2600°F all the way down to 200°F. On the other hand, Osburne deals with low gas temperature reactions at several 100°F to reduce all the cited pollutants. This occurs in the exhaust ducting upstream of the stack, with procedures that differ totally from the present invention

One example of the uniqueness of the claimed processes is the use of a time dependent process to encapsulate mercury in the nominal 2000°F slag lining the walls of the 3000°F gas in an air cooled combustor. Mercury vaporizes at 662°F (350°C). This Hg process is only feasible in an air cooled combustor where the transit time of mercury containing ash droplets or particles is less than the time for evolution of Hg into the 3000°F combustion gases. There is no other process that can accomplish this. This is described in the Summary of the Invention as "Kinetic Vitrification" (p.31, line 9 to page 32 line 10). Details of this mercury capture process are explained on pages 40 line 8 through page 42 line 4. The volatile metals in coal ash, that includes mercury, arsenic, lead, sulfur, remain trapped in the ash particles in the short milliseconds time that coal ash particles traverse the combustion gases at 3000°F from coal particles injection until ash particles impact and encapsulation in the liquid (nominal 2000°F) slag layer lining the combustor wall. The slag is drained in a few minutes to the water quenching tank to prevent re-evolution of the volatile metal into the combustion gases.

Another novel mercury capture process inside the combustor is to inject activated char in the coal injection zone of the combustor to capture mercury released from the coal combustion in the gas phase. (Page 46, lines 11 through page 47 line 2. The analysis of this process to capture mercury in the combustor at nominal 3000°F is described from page 47 , line 4 to page 52 line 2.

Osborne does not address the unique Group 1 processes to capture mercury. Another Group 1 process not addressed by Osborne is reduction of NO<sub>x</sub> in the 3000°F combustion gases in the combustor. Another unique process in Group 1 inside the 3000°F gases in the combustor is to remove SO<sub>2</sub> with lime or limestone., the latter of which consists of non-equilibrium SO<sub>2</sub>

capture by rapidly calcined lime or limestone particles, followed by impact of the calcium-sulfur oxide particles in the slag lining the combustor wall, followed by rapid slag removal and quenching in a water tank. Osborn simply does not mention this process.

The invention also optimizes this two step SO<sub>2</sub> capture process by using sulfur powder to generate fixed levels of SO<sub>2</sub>, as opposed to coal with its widely variable sulfur levels in even one load of coal. The second step in this optimization is to use a high ash, non-sulfur content material, namely, rice husk char, to optimize this two-step SO<sub>2</sub> capture process in the combustor. In this way the sulfur capture process can be optimized. Again , Osborne does not even address any of these unique Group 1, NO<sub>x</sub>, SO<sub>2</sub> and mercury trace metal emission control processes of the present invention.

Another part of this invention is a means for reducing dioxin/furans in the post combustor/post-combustor zone, which again is not mentioned in Osborne. Also, the claimed invention provides for lowering the gas temperature in order to sharply reduce dioxin/furans by up to a factor of 1000, as well as greatly reducing the ratio of activated carbon to further reduce dioxin/furan. This is an important consideration due to the high cost of activated carbon.

Another unique application is to use NO<sub>x</sub> reduction by Selective Non-Catalytic Reduction by urea or ammonia injection in the combustion gas temperature range between about 1700°F and 2500°F (page 66, line 15 to p.67. line 4). As per above, this provides for the implementation of the low temperature mercury and dioxin/furan reduction in this invention (p.67, line 17 to 19). Osborne does not show this feature.

Another unique application is post-combustion SO<sub>2</sub> removal by injection of lime or limestone in the same gas temperature zone as the present SNCR NO<sub>x</sub> process. Also this will remove chlorine in the gas stream (page 67, line 13 ). The removal of NO<sub>x</sub>, SO<sub>2</sub>, and chlorine upstream is important to the removal of mercury and dioxin/furans because it enables their removal at low gas temperatures (p.67, line 18-19) that are below the dew point of the acid causing species that attack metal walls in the ducting (p/67, lines 20-23, p. 68, lines 1-3). This allows the use of much lower concentrations of very costly activated carbon to remove the remaining mercury and dioxin/furans (p.68, line 5 to p.69, line 19). Finally, as all the other

pollutants have been removed it allows removal of any remaining mercury removal (p. 69. line 20 to page 70, line 4) with no concern that the activated carbon is being diverted to reducing remains of the other species. In conclusion this sequential reduction of NO<sub>x</sub>, SO<sub>2</sub>, Hg, dioxin/furans, and other volatile trace metals from coal combustion occurs uniquely in the various specified gas temperatures zones. This is not mentioned in Osborne.

In conclusion, Osborne has absolutely no relevance to claimed invention, as is immediately apparent from its Abstract which discloses the addition of ozone to convert the pollutants into soluble compounds to be mixed with water, from which processes using other patents would extract them. This entire Osborne invention operates only at liquid water temperatures of several 100°F. This point is made clear thought the Osborne disclosure (and as recited in claims 1, 2, 3, 4, 5, 6, and 8).

Osborne has simply substituted a new chemical plant to replace the costly current stack cleanup systems, SNCR for NO<sub>x</sub>, scrubbers for SO<sub>2</sub> and Hg. Also, Osborne does not use lime, limestone, or ammonia, nor does it require combustion. (See, paragraph 0043). Also, all pollutants are removed at one narrow range of gas condition. (See, paragraph 0045.) None of this applies to the claimed invention. The Osborne process is also certainly far more expensive than the claimed invention, in that for a 273 MW power plant, the diameter of the system is 36 feet in diameter in one module. (See, paragraph 0100.) Basically Osborne proposes using Henry's Law of solubility to convert NO<sub>x</sub> and SO<sub>x</sub> into soluble species by mixing with ozone. (See, paragraph 0102 through 0106.) Therefore, Osborne is not relevant to the claimed invention.

Accordingly, Applicants respectfully request that the rejection over claim 1-33 be withdrawn.

### **35 U.S.C. §103 Rejection**

Claims 1-34 were rejected under 35 U.S.C. §103(a) for being obvious by the U.S. Patent No. 6,352,956 to Kienow in view of U.S. 2002/0061270 to Osborne. This rejection is respectfully traversed.

The Examiner bears the initial burden of factually supporting any *prima facie* conclusion of obviousness. To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach all the claim limitations. MPEP § 2142. Applicant respectfully submits that the applied references do not teach or suggest all of the claim limitations.

In addition to the above arguments will regard to Osborne, Applicant submits that Kienow is also not relevant to the claimed invention. Kienov uses a downward flowing dry gas duct to react with activated coke to remove pollutants (e.g. Col. 2, line 54 to line 63). Kienow adds inert compounds such as calcium-based powders, to prevent dust explosions from the coke with the oxygen in the ducts. (Col. 3, lines 61 to 67 and Col. 4, line 1 to line 22, and Col. 6, line 9 to line 20). Moreover, much like Osborne, Kienov operates entirely in the low gas temperature range of several 100°F, and thus requires extensive and costly chemical components to control emissions, as discussed. Kienov also does not even address any of these unique Group I, NO<sub>x</sub>, SO<sub>2</sub> and mercury trace metal emission control processes that are claimed in the present invention. Therefore, Kienov is a totally different process from the claimed invention in which the pollution removal reagents are dispersed in water.

Additionally, the Examiner's statement "There is nothing in Osborne suggesting that the walls of the furnace or boiler are impaired by the process" is incorrect. Osborne only operates in the temperature range of around 200°F, where water is a liquid, and that is certainly a function of the wall temperature. On the other hand, the claimed invention recites pollutant reduction processes that occur over most of the combustion gas temperature range from about 3000°F to about 200°F.

Accordingly, Applicants respectfully request that the rejection over claim 1-33 be withdrawn.

**CONCLUSION**

Applicant submits that all of the claims are patentably distinct from the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue. The Examiner is invited to contact the undersigned at the telephone number listed below, if needed. Applicant hereby makes a written conditional petition for extension of time, if required. Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 19-0089.

Respectfully submitted,



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